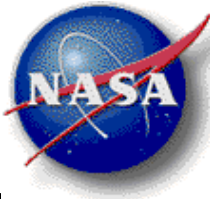# Overview of Graphical User Interface for ARRBOD (Acute Radiation Risk and BRYNTRN Organ Dose Projection)

Myung-Hee Y. Kim,[1] Shaowen Hu,[1] Hatem N. Nounu,[1] and Francis A. Cucinotta[2]

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Brief Overview

❑ **Acute Radiation Risk (ARR) and BRYNTRN with SUMDOSE codes are developed at NASA JSC.**

❑ **BRYNTRN is a Baryon transport code with an output data processing module of SUMDOSE written in FORTRAN; and ARR in C.**

❑ **A future version to estimate cancer risks will use FORTRAN/C++.**

❑ **The risk models (Organ dose, ARR, & Cancer) take the output from BRYNTRN as input for the calculations.**

❑ **BRYNTRN code operation requires extensive input preparation.**

→ **With GUI to handle input and output for BRYNTRN, the response models can be connected easily and correctly to BRYNTRN in friendly way.**

Objectives

- ❑ **Support of mission/spacecraft design and operational planning to manage radiation risks in space missions.**

- ❑ **NASA trade studies of mission scenarios, shielding materials, masses and topologies for protection of astronauts from space radiation.**

- ❑ **Proper shielding solutions to avoid ARR symptoms and to stay within the current NASA Dose limits.**

- ❑ **Quantified evaluation of dose and ARR severity to guide alternative solutions for the determined objectives set by mission planners.**
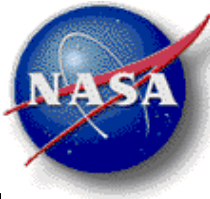
Complexity and Innovation

❑ The integration of risk projection models of organ doses and acute radiation risk has been a key problem for human space applications.

❑ Baryon transport (BRYNTRN) code operation requires extensive input preparation.

❑ Only a graphical user interface (GUI) can handle input and output for BRYNTRN to the risk response models easily and correctly in friendly way.

❑ A GUI for the Acute Radiation Risk and BRYNTRN Organ Dose (ARRBOD) projection code provides seamless integration of input and output manipulations, which are required for operations of the ARRBOD modules: BRYNTRN, SUMDOSE, and the ARR probabilistic response model.

❑ A proof-of-concept for future integration of other risk projection models for human space applications.
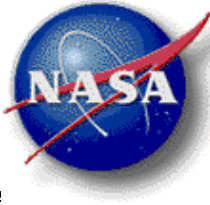
Applicability

- ❑ **Mission and spacecraft designers**

- ❑ **Aerospace engineers**

- ❑ **Space operations in the Mission Operations Directorate (MOD)**
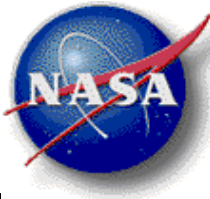
- ❑ **Space biophysicists**
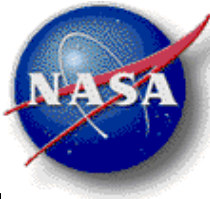
Release History

❑ **Beta version released to the testers in May 2009.**

❑ **Version 1 released to US citizens and ISS partner nations in March 2010.**
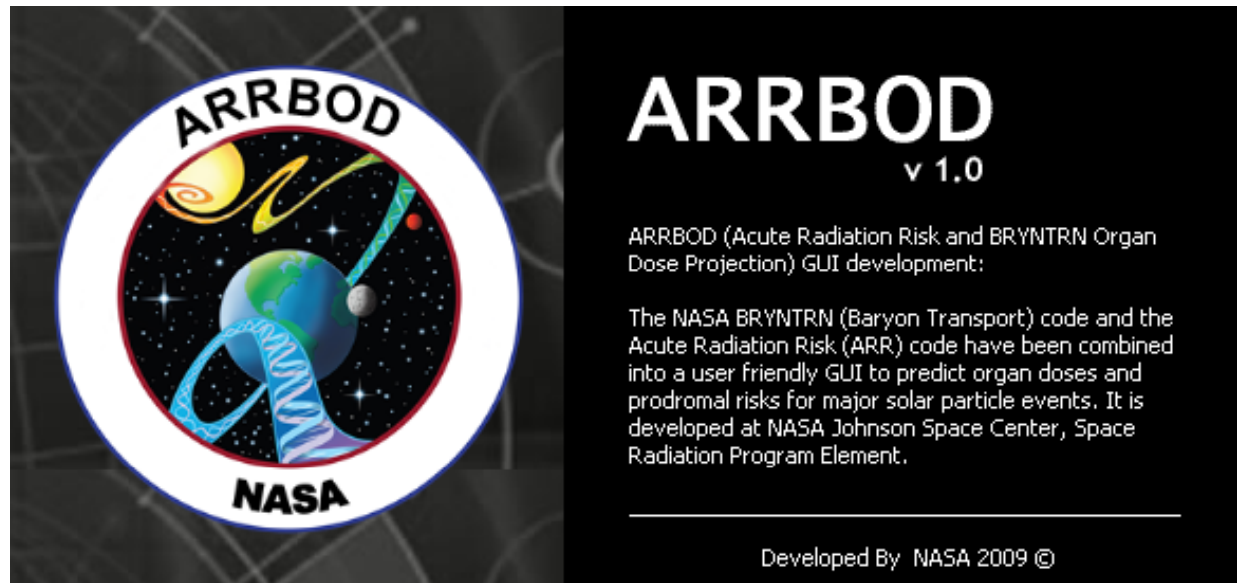
❑ **NASA TP-2010-216116 distributed to the managers and researchers at NASA centers and to the researchers at US academia/research institutes in March 2010.**
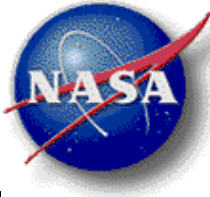
Development of Graphical User Interface for ARRBOD
(Acute Radiation Risk and BRYNTRN Organ Dose Projection)

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Future Plans for Development and Use

- ❑ **Add functionalities**
  - **- Shield file supplied by user**
  - **- SPE spectra data files supplied by user**
- ❑ **Add blood kinetics to ARR model.**
- ❑ **Add cataract risk project based on NASA Study of Cataracts in Astronauts (NASCA) and NASA Space Radiation Laboratory (NSRL) data.**
- ❑ **Add Probabilistic Risk Assessment (PRA) approach to SPE protection (Hazard function).**
- ❑ **The deterministic method of ARRBOD to be evolved to GCR Event-based Risk Model (GERM) Space code for the description of time-dependent biophysical events with reduced uncertainty.**
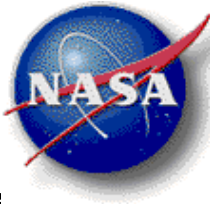
- ❑ **Overall I/O Sequences of Risk Calculations**
- ❑ **Output of ARR Sickness Severity Levels**
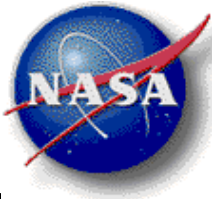- ❑ **Output of Organ Dose for SPE Exposure**
- ❑ **References**

Overall I/O Sequences of Risk Calculations
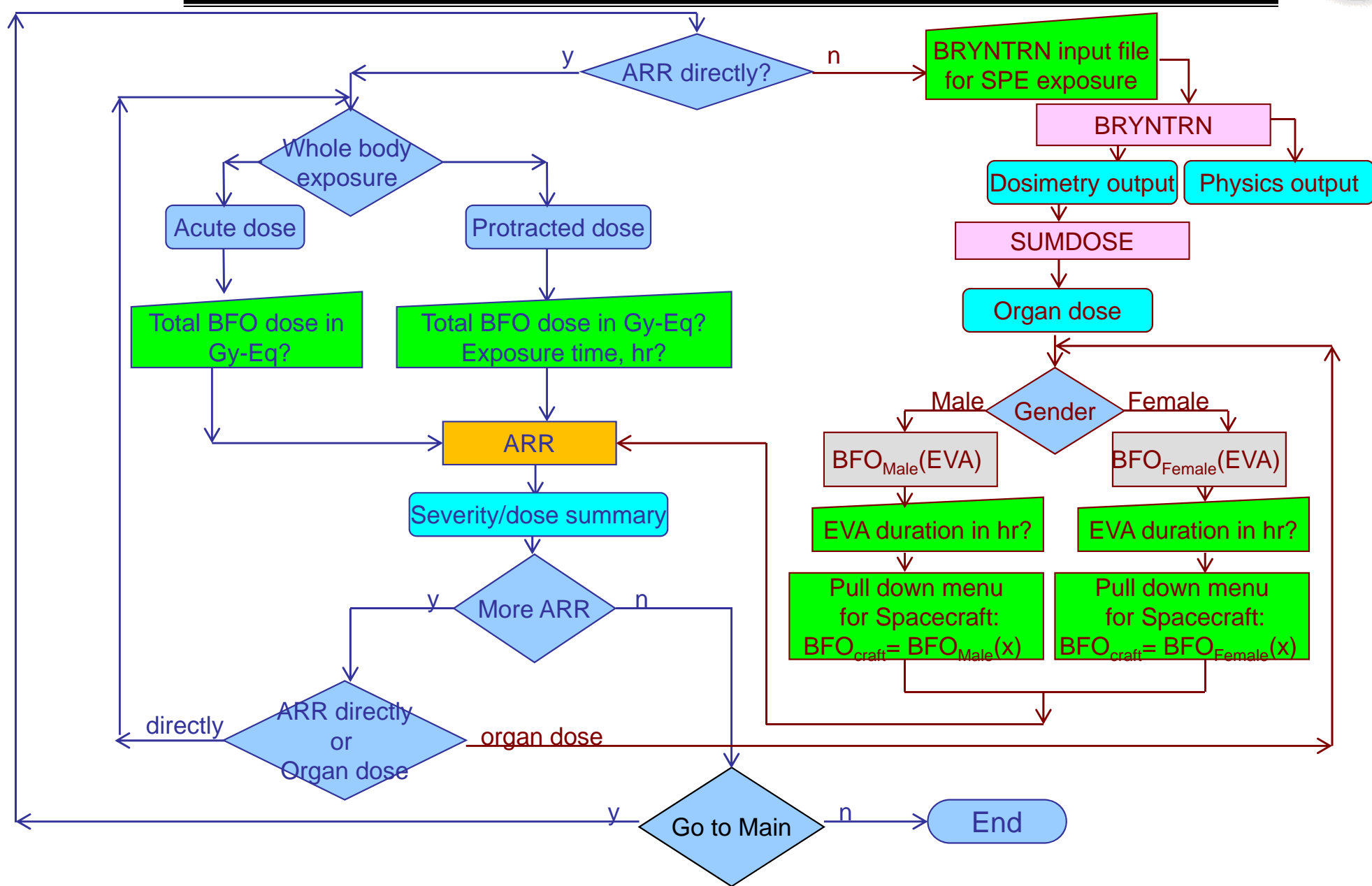
ARR Sickness Severity Levels

| Severity level	Upper Gastrointestinal Distress (UG)	Fatigability and Weakness (FW)
1	No effect	No effect
2	Upset stomach, clammy and sweaty, mouth waters	Somewhat tired with mild weakness
3	Nauseated, considerable sweating, swallows frequently to avoid vomiting	Tired with moderate weakness
4	Vomited once or twice, nauseated, and may vomit again	Very tired and weak
5	Vomited several times, including the dry heaves, severe nauseated, and will soon vomit again	Exhausted with almost no strength

BRYNTRN/SUMDOSE Output

Exposure limit by NASA*	Organ dose, Gy-Eq
30-d limit at Skin	1.5
30-d limit at Eye	1.0
30-d limit at BFO	0.25
Min BFO dose for ARR	0.5

*National Research Council/National Academy of Sciences (NRC/NAS), Committee on the Evaluation of Radiation Shielding for Space Exploration. Managing space radiation risk in the new era of space exploration, the National Academies Press; 2008.

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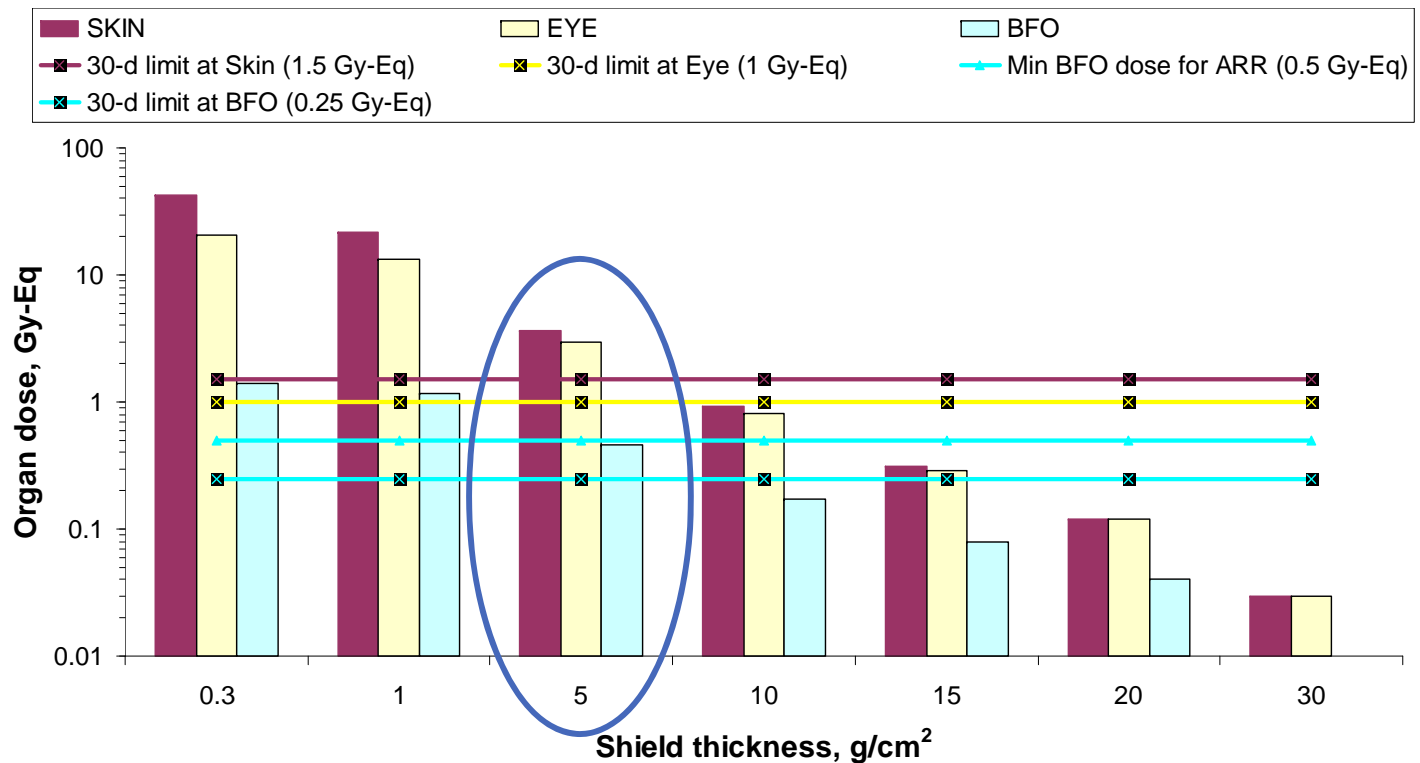
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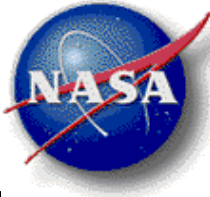
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